

CLAIMS

1. Method for establishing at least a limit value ( $t_{max}$ ) for at least a first operational parameter ( $t$ ,  $PLIN$ ,  $P$ ,  $\Delta I$ ) of a nuclear reactor (1) comprising a core (2), in which fuel assemblies (16) are loaded, the fuel assemblies (16) comprising  
5 fuel rods (24) each comprising pellets (36) of nuclear fuel and a cladding (33) which surrounds the pellets (36), characterized in that it comprises the steps of:

b) simulating at least a transient operational occurrence of the nuclear reactor (2),

c) calculating the value reached by a physical quantity ( $\sigma_\theta$ ) during the  
10 transient operational occurrence in at least a cladding (33) of a fuel rod (24) and

d) establishing, as a limit value, the value of the first operational parameter when the value calculated in step c) corresponds to a value ( $\sigma_{\theta RUP}$ ) for the physical quantity which characterizes a failure of the cladding (33).

2. Method according to claim 1, characterized in that it comprises, before  
15 step b), a step for:

a) establishing a failure value ( $\sigma_{\theta RUP}$ ) for the physical quantity which characterizes a failure of the cladding (33).

3. Method according to claim 2, characterized in that step a) comprises the subsidiary steps of:

20 a1) subjecting fuel rods (24) to gradients of nuclear power,

a2) calculating the values reached ( $\sigma_{\theta MAX}$ ) by the physical quantity ( $\sigma_\theta$ ) in at least a cladding (33) which has failed during a power gradient,

a3) selecting the minimum value from the values reached which are calculated in step a2).

25 4. Method according to claim 3, characterized in that the failure value used in step d) is equal to the minimum value selected in step a3).

5. Method according to claim 3, characterized in that the failure value used in step d) is equal to the minimum value selected in step a3) and corrected by a factor which represents an operating mode of the reactor.

30 6. Method according to any one of the preceding claims, characterized in that it comprises, before step c), a step for:

b') establishing at least a fuel rod (24) whose cladding (33) is the most stressed during the transient occurrence simulated in step b),

and in that step c) is carried out for the or each rod (24) which is established in step b').

7. Method according to claim 6, characterized in that step b') comprises the subsidiary steps of:

5        b'1) evaluating the value reached by the physical quantity ( $\sigma_\theta$ ) in the claddings (33) of a plurality of fuel rods (24), and

      b'2) selecting, as the rod whose cladding (33) is the most stressed, the rod (24) whose value evaluated in step b'1) is the highest.

8. Method according to any one of the preceding claims, characterized in  
10 that the first operational parameter is the power per unit length (PLIN) supplied by a fuel rod (24).

9. Method according to any one of claims 1 to 7, characterized in that the first operational parameter is a period of time (t) for operation of the reactor (1) at an intermediate power less than its nominal power (PN).

15        10. Method according to any one of the preceding claims, characterized in that the limit value is a limit value for triggering an emergency shutdown of the reactor (1).

      11. Method according to claim 10, characterized in that it further comprises at least a step for:

20        e) establishing a limit value for triggering an alarm from the limit value for an emergency shutdown established in step d).

      12. Method according to any one of the preceding claims, characterized in that step b) is carried out for at least an operating mode of the reactor (1) selected from the group constituted by:

25        - an operating mode at a total power of the reactor (1) equal to its nominal power,

      - an extended operating mode at intermediate power, in which the total power of the reactor (1) is less than its nominal power over a period of time of at least 8 hours per period of 24 hours,

30        - a continuous network operating mode, in which the total power varies alternately around a high power (PN ; PE) and around a low power (PR),

- a primary control operating mode, in which the total power of the reactor (1) varies by from 0 to 5% around a reference value in the order of between 95 and 100% of the nominal total power of the reactor (2).

13. Method according to claim 12, characterized in that, for at least an  
5 operating mode, the steps b) to d) are used for another operating mode with, as the failure value of the physical quantity, the failure value of that other operating mode corrected by a corrective value.

14. Method according to any one of the preceding claims, characterized in that the transient occurrence simulated in step b) is a transient occurrence  
10 selected from the group comprising:

- an excessive increase in load,
- an uncontrolled removal of at least a group of control clusters (20),
- one of the control clusters (20) falling.

15. Method according to any one of the preceding claims, characterized in  
15 that the physical quantity is a stress or a function of stress(es) in the cladding (33).

16. Method according to any one of the preceding claims, characterized in that the physical quantity is a deformation energy density in the cladding (33).

17. System (40) for establishing at least a limit value for an operational  
20 parameter of a nuclear reactor (2), characterized in that it comprises means (42, 44, 46, 48) for carrying out the steps of a method according to any one of the preceding claims.

18. System according to claim 17, characterized in that it comprises at least a computer (42) and storage means (44), in which at least a program for  
25 carrying out steps of the establishing method carried out by the system are stored.

19. Computer program comprising instructions for carrying out the steps of a method according to any one of claims 1 to 16.

20. Medium which can be used in a computer and on which a program  
30 according to claim 19 is recorded.